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ABSTRACT

This study explored the variance in mathematical problem-solving achievement accounted for by sex and ethnicity. Each of 316 adolescents in a rural school district in southeast Texas was administered the California Achievement Test and a set of five affective scales. Reading scores accounted for 49.5% of the variance; computation, 14.6%; affective scales, 1%; sex and ethnicity, 0.58%. Thus, no significant sex or ethnic differences were found in problem-solving ability when the effects of reading and computation were removed. The researchers concluded that this could indicate that males and females, blacks, whites, and chicanos are equally good (or equally poor) problem-solvers when they have similar reading and computational skills. (MNS)

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Sex Related Differences in Problem-Solving in Rural

Black, Anglo, and Chicano Adolescents

The development of problem-solving skills has been identified as the focus for school mathematics in the 1980's by the National Council of Teachers of Mathematics (NCTM). In its Agenda for Action: Recommendations for School Mathematics of the 1980's, NCTM has advocated that the teaching of problem-solving skills have the highest priority in school mathematics. Additionally, the results of the widely publicized second National Assessment of Educational Progress (NAEP) indicates that the 9, 13, and 17 year-olds who participated in the study "demonstrated a lack of the most basic problem-solving skills" (Carpenter, et. al., 1980).

It is established by previous studies that mathematics achievement, of which problem-solving is a component, is affected by several factors. Of these factors, sex and ethnic group differences in mathematics achievement have been the subject of several recent studies. Fennema & Sherman (1978) have found significant sex differences in mathematics achievement. Creswell & Houston (Note 1) and Creswell & Johnson (1981) have found significant ethnic differences.

Affective factors influencing mathematics achievement include attitude towards mathematics, perceived usefulness of mathematics, perceived attitude of mother, father, and teacher, and the feeling that mathematics is a masculine activity. Each of these influences has been reported in regards to overall mathematics achievement, but not to problem-solving specifically, utilizing a sample from a rural area.

The purpose of the present study was to investigate the following questions:

(1) Do the control variables of reading and computation meet the assumption of homogeneity of regression slope?

(2) Is the proportion of variance accounted for by the affective variables as a set, after the effects of reading and computation have been removed, statistically significant?

(3) Is the proportion of variance accounted for by the affective variables individually, after the effects of reading and computation have been removed, statistically significant?

(4) Is the proportion of variance accounted for by the set of vectors carrying group membership and the interaction of sex and ethnicity statistically significant?

(5) If question 4 is answered affirmatively, then do the individual vectors of sex, ethnicity, and sex and ethnicity interaction account for a statistically significant proportion of the variance?

Method

Sample

The study was conducted in a rural school district in South-east Texas. Subjects consisted of three hundred sixteen adolescents of whom seventy-three were white females, sixty-five were white males, sixty-nine were black females, sixty-four were black males, twenty-one were Chicano females, and twenty-four were Chicano males.

Instrumentation

Each subject was administered the California Achievement Test, 1970 Edition, from which a composite reading score along with two mathematics component scores, computation and problem solving, were selected for analysis.

Additionally, each subject was administered a set of five affective scales. The Aiken and Dreger Revised Math Attitude Scale was used to measure the student's attitude towards mathematics. Four scales developed by Fennema and Sherman (Note 2) were used to measure each student's perception of 1) his mother's attitude toward mathematics, 2) his father's attitude toward mathematics, 3) mathematics as a masculine activity, and 4) the usefulness of mathematics. Each scale was scored by a Likert-type sliding scale ranging from one to five for each response item.

Procedures

The dependent variable of problem-solving (one of the two component scores) was analyzed as a function of ten independent variables. Of these ten, reading and computation (the second component score) were the control variables. The categorical variables of sex and ethnicity together with the interaction of sex and ethnicity were coded into a set of five vectors. The affective scales were analyzed as a set and separately, although it is recognized that the relative importance of each variable is affected by its order of entry into the equation, and its correlation with the other independent variables.

Stepwise multiple regression techniques (Kerlinger & Pedhazur, 1973) were used to analyze the data. From the dependent variable of problem-solving, the effects of reading and computation were removed. The set of affective scales were entered next, and tested for significance as a set and individually. The five vectors representing sex, ethnicity, and sex by ethnicity interaction were entered next and tested for significance. Finally, interaction vectors were entered to test for homogeneity of regression slope for the control variables across the categorical variables of sex and ethnicity.

Results

The multiple regression analysis revealed that 65.2% of the variance was accounted for by the full regression model. Reading scores accounted for 49.5% of the variance, significant at $p<.01$ (see Table 2). Computation scores accounted for 14.6% of the variance, significant at $p<.01$. As a set, the affective scales accounted for only 1% of the total variance, a nonsignificant relationship. However, a post hoc probe revealed that father influence by itself was a significant relationship at $p<.05$. The categorical variables of sex and ethnicity together with the interaction of sex and ethnicity accounted for only .58% of the total variance, a non-significant relationship.

The use of reading and computation as covariates was validated by a trivial (essentially zero) interaction of the covariates with the categorical variables. Therefore, the assumption of homogeneity of regression slope was met and the interaction vectors excluded from the model.

Since the effects of sex and ethnicity were confounded by unequal cell size, two separate analyses were conducted with the order of entry of the variables into the equation reversed, thus a pure measure of the individual contributions of sex and ethnicity was obtained. No significant confounding of effects was revealed by this procedure.

Discussion

The present study revealed no significant sex or ethnic differences in problem-solving ability when the effects of reading and computation were removed. This could indicate that males and females, blacks, whites, and chicanos are equally good (or equally poor) problem-solvers when they have similar reading and computational skills.

The finding that reading accounts for 49.5% of the variance in problem-solving is not surprising, and is consistent with the findings of Johnstone (Note 3). The lack of ethnic differences is not consistent with previous findings by Creswell & Houston (Note 1), and Creswell & Johnson (1981). The lack of sex differences is not consistent with the findings of Fennema (1974) and several other researchers.

Perhaps the results of this study can be at last partly explained by the dependent variable, problem solving and the two control variables reading and computation. The subjects were from a school district ranked at near the bottom, academically, of all Texas school districts (see Table 1). For example, the mean score for the district in problem solving in national percentiles was 30.3 and only slightly better for reading and computation. Consequently, such a uniformly low achievement level of the 316 subjects would tend to restrict the amount of variance of these variables and thus, lend credence to the conclusion that when assessing achievement in problem solving, one is also assessing reading achievement (see Table 2). Also, the possibility exists that the California Achievement Test was not an appropriate instrument for use with this population.

Another problem is that of each of significant correlations between the five affective scales. Since each is competing for entry into the equation, and the relative importance is dependent upon the order of entry, the unique role of each scale is difficult, if not impossible, to measure.

Further study of problem-solving should include a control for reading, especially if problem-solving is assessed by using a standardized test. Additionally care should be taken to assure that an appropriate instrument be used for assessing cognitive skills. Equal cell size for the sex and ethnic groups would be advantageous for interpretation purposes.

Reference Notes

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2. Fennema, E. & Sherman, J. Sex-related differences in mathematics learning: Myths, realities, and related factors. Paper presented at the annual meeting of the American Association for the Advancement of Science, Boston, February, 1976.

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Table 1

Summary of Means and Standard Deviation

Variable	Mean	S.D.	N
Problem solving	43.26	8.50	3.16
Computation	44.29	7.77	3.16
Reading	44.40	7.85	3.16

Table 2

Summary of Multiple Regression analysis

Variable	R^2	R^2 change	df	F
Reading	.49491	.49491	1/315	452.14**
Computation	.64148	.14657	1/314	133.48**
Father Influence	.64672	.00523	1/313	4.7476*
Male Domain	.64861	.00196	1/312	1.7935
Usefulness	.65137	.00269	1/311	2.4261
Mother Influence	.65196	.00059	1/310	.53093
Math Attitude	.65200	.00004	1/309	.35845

**Significant at p<.01

*Significant at p<.05